

MAG Planners Stakeholders Group
Tuesday, August 19, 2008
Outdoor Light Pollution Standards



Dan Brocious, Smithsonian Institution, Whipple Observatory and
Christian B. Luginbuhl, US Naval Observatory, Flagstaff Station

Stakeholders:

(contributing to today's presentation)

Dan Brocious, Fred Lawrence Whipple Observatory, and Board member of International Dark Sky Association

Patrick Burkhart, President, Arizona Arts, Sciences and Technology Academy

Christopher Corbally, Vice Director, Vatican Observatory

Michael Drake, Director, Lunar & Planetary Laboratory, Univ. of Arizona

Richard Green, Director, Large Binocular Telescope Obs., Univ. of Arizona

Buell Jannuzi, Director, Kitt Peak National Observatory, and Board member of International Dark Sky Association

Christian Luginbuhl, US Naval Observatory, Flagstaff Station

Robert Millis, Director, Lowell Observatory

Paul Smith, Steward Observatory, U of A, ASU & NAU

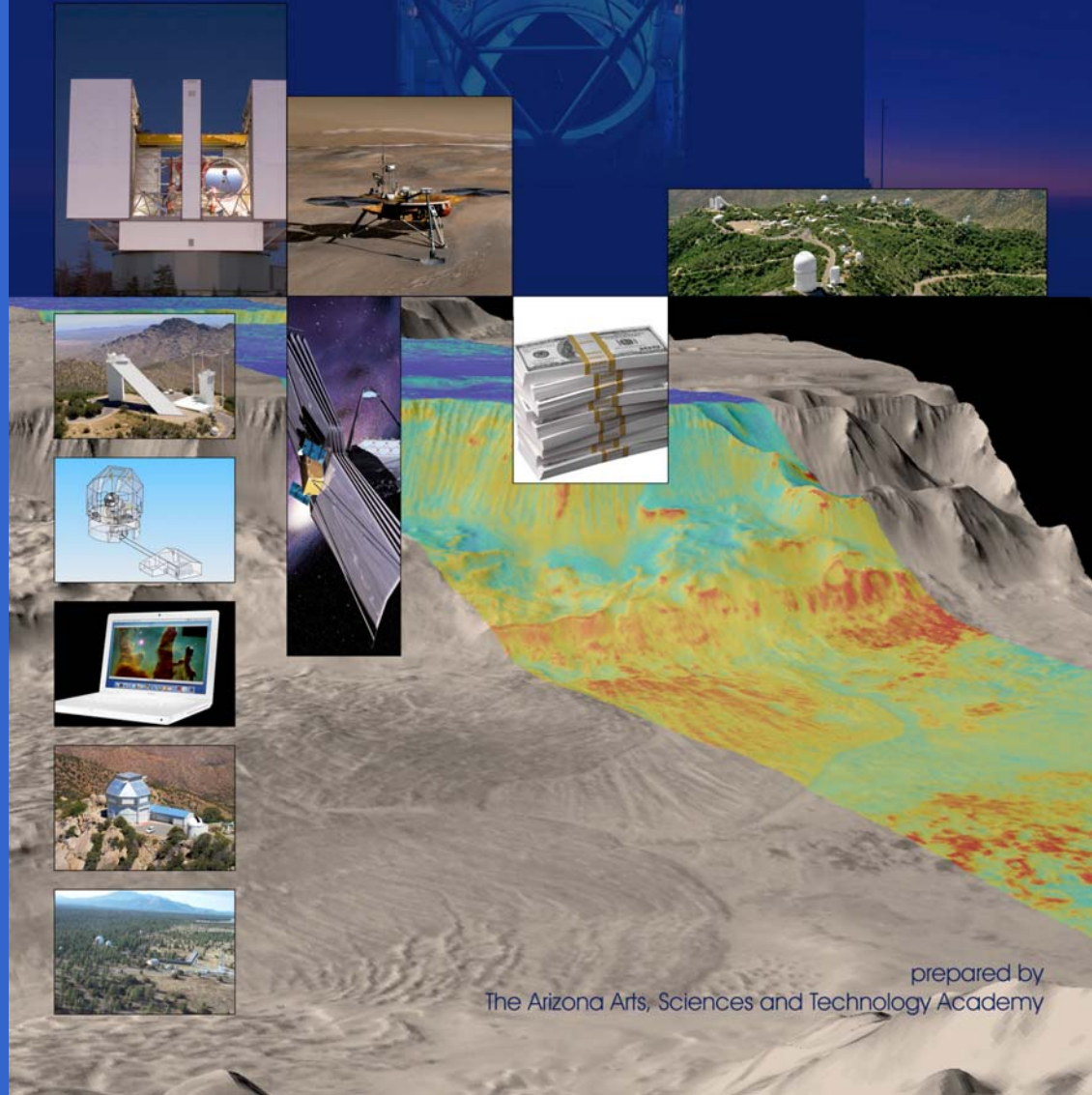
Rogier Windhorst, School of Earth & Space Exploration, Arizona State University

And the students, employees and suppliers of Arizona's astronomy industry.

*Stargazing nets \$250 mil a
year for Ariz. economy*

*The Arizona Republic
January 17, 2008.*

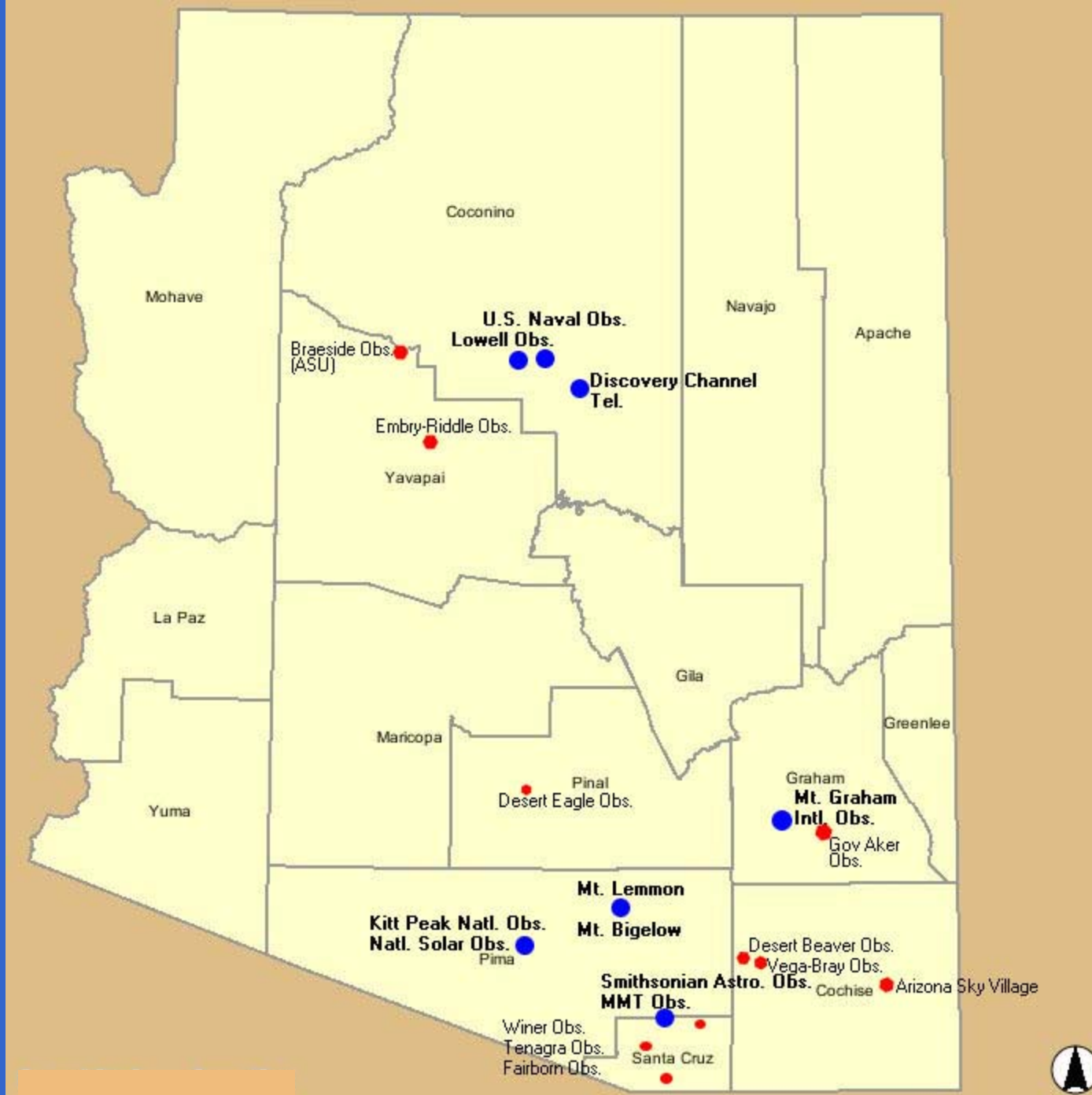
Astronomy, Planetary Sciences,
and Space Sciences Research Opportunities
to Advance Arizona's Economic Growth



prepared by
The Arizona Arts, Sciences and Technology Academy

Astronomy is worth billions to Arizona

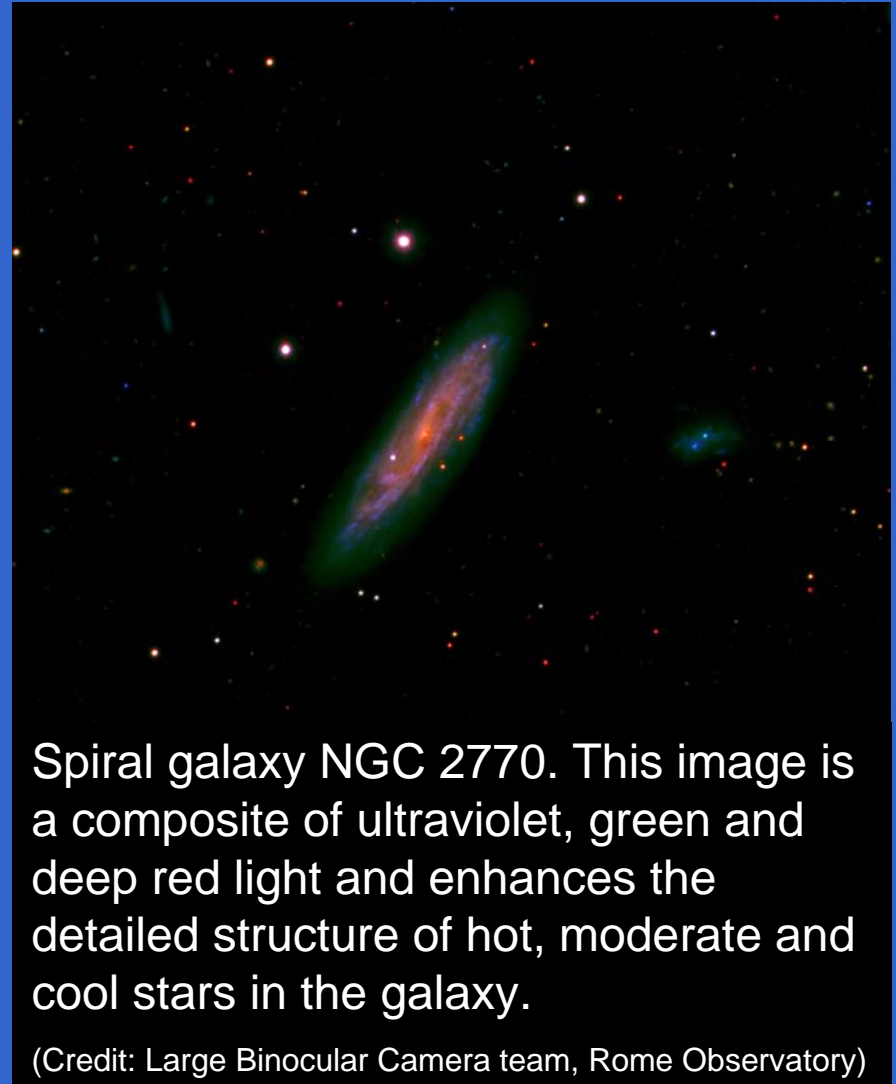
This study found substantial capital investment (in excess of \$1 billion) in, and economic return (nearly a quarter of a billion dollars annually) from APSS research in Arizona. The data also suggest the untapped potential of these research fields to expand the State's economic base. The study revealed levels of active research funding that well exceed other fields in the State, such as bioscience funding from the National Institutes of Health.



World's Largest Telescope Achieves First Binocular Light

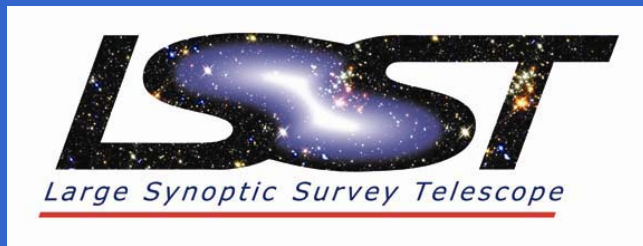


The Large Binocular Telescope on Mount Graham, Ariz., has taken celestial images using its twin side-by-side, 8.4-meter (27.6 foot) primary mirrors together, achieving first "binocular" light. March 6, 2008



Spiral galaxy NGC 2770. This image is a composite of ultraviolet, green and deep red light and enhances the detailed structure of hot, moderate and cool stars in the galaxy.

(Credit: Large Binocular Camera team, Rome Observatory)



Steward Observatory Mirror Lab Awarded Contract for Large Synoptic Survey Telescope Mirror

The LSST Corporation has awarded a \$2.3 million contract to the University of Arizona Steward Observatory Mirror Lab to purchase the glass and begin engineering work for the 8.4-meter diameter main mirror for the Large Synoptic Survey Telescope (LSST)...

Acquiring the LSST primary mirror was made possible by a generous, private pledge from Arizona businessman Richard Caris.

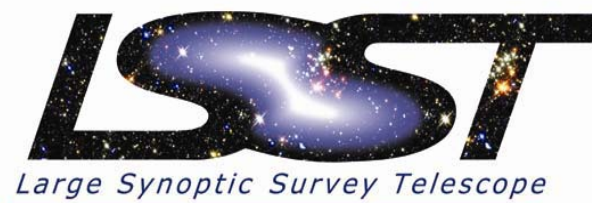
January 2005

You don't have to be an Arizona benefactor to support astronomy

EMBARGOED FOR RELEASE: January 3, 2008

RELEASE LSSTC-06

LSST Receives \$30 Million from Charles Simonyi and Bill Gates



The Large Synoptic Survey Telescope (LSST) Project is pleased to announce receipt of two major gifts: \$20M from the Charles Simonyi Fund for Arts and Sciences and \$10M from Microsoft founder Bill Gates.

Under development since 2000, the LSST is a public-private partnership. This gift enables the construction of LSST's three large mirrors; these mirrors take over five years to manufacture. The first stages of production for the two largest mirrors are now beginning at the Mirror Laboratory at the University of Arizona in Tucson, Arizona. Other key elements of the LSST system will also be aided by this commitment...

UA Mirror Lab to Cast Two Mirrors in One for the LSST

Mirror Lab workers load 51,900 pounds of glass into mirror mold.

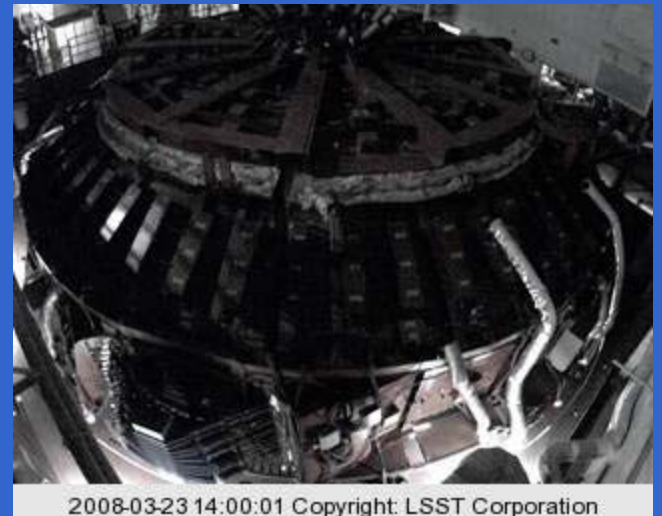
March 17, 2008.



Steward Observatory Mirror Lab workers installed 1,160 ceramic cores in the mirror mold that was made for casting the primary and tertiary mirrors as a single piece of glass for the LSST.

(Ray Bertram, Steward Observatory)

The mirror high fire was successful reaching a high temperature of approximately 1165°C (2125°F) over March 28th and 29th. The LSST mirror is now annealing and cooling gradually to room temperature in the slowly rotating oven of the Steward Observatory Mirror Lab. Technicians will remove it for grinding and polishing in mid-August.



2008-03-23 14:00:01 Copyright: LSST Corporation

4.2 meter Discovery Channel Telescope under construction in Northern Arizona



Rendering of the DCT facility and dome

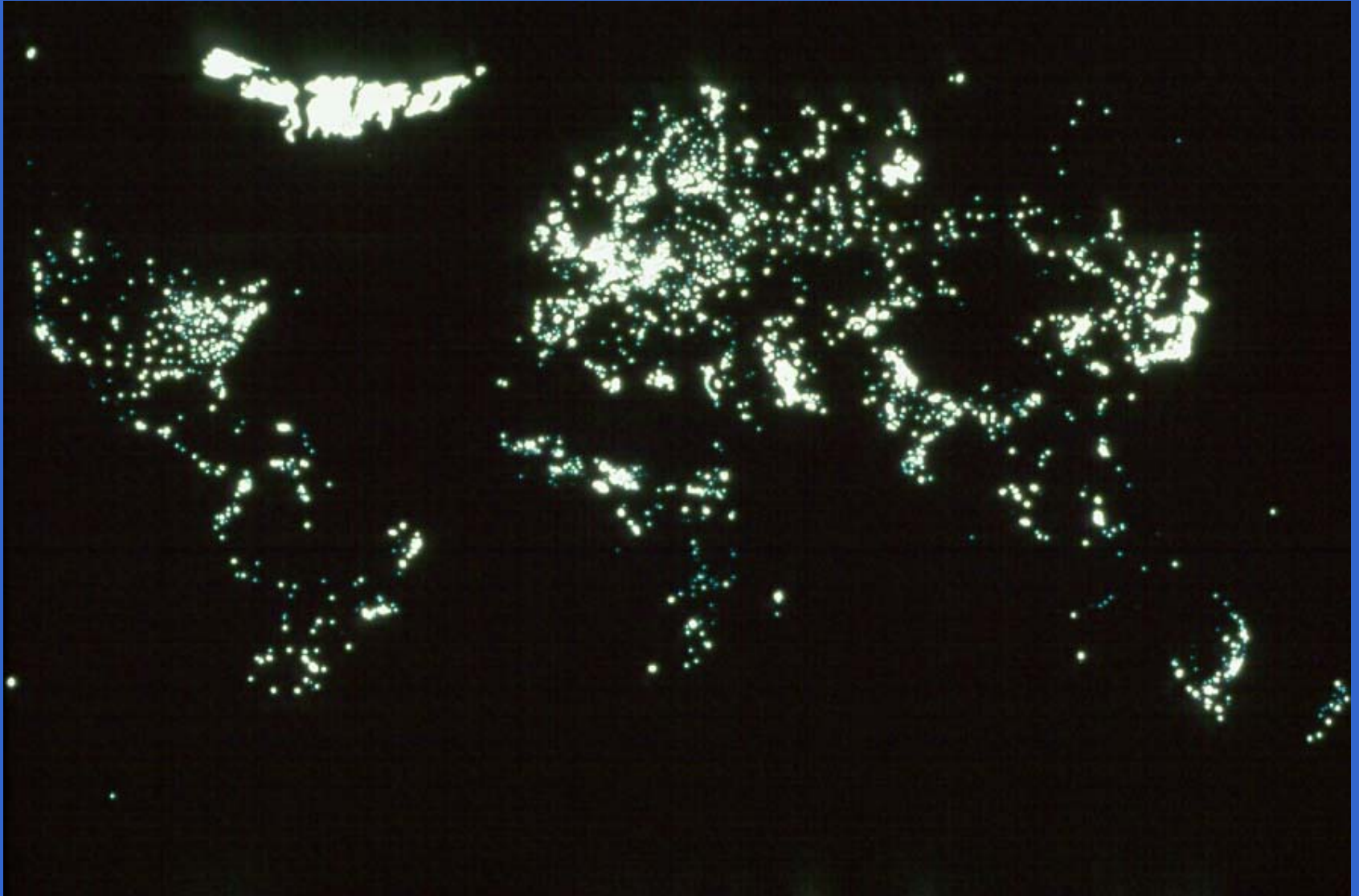
Forty miles southeast of Flagstaff, atop a cinder cone at a site known as Happy Jack, the 4.2 meter Discovery Channel Telescope is under construction. Developed by Lowell Observatory in partnership with Discovery Communications, Inc., the DCT will be operational in 2010. It will be a powerful tool for research areas including the search for Near Earth Objects (NEOs), extrasolar planets, and exploration of the newly discovered Kuiper Belt. It will also expand opportunities for public outreach and education in the exciting world of science and technology.

Recommendation 4

The Arizona Legislature, counties, municipalities and Tribal Nations should revisit the adequacy and enforcement of existing statutes and ordinances in a new effort to reduce light pollution associated with rapid industrial and population growth as well as old lighting installed before effective codes were in place.

Arizona Title 49, Chapter 7 calls for the elimination of mercury vapor lighting fixtures by 2011. All counties in the State and many municipalities have used the 1973 State law to enact light control ordinances. However the sheer rate of population growth, particularly in Maricopa County, and more recently in Pinal County, as well as lax enforcement of many existing ordinances, threaten to undo that protection.

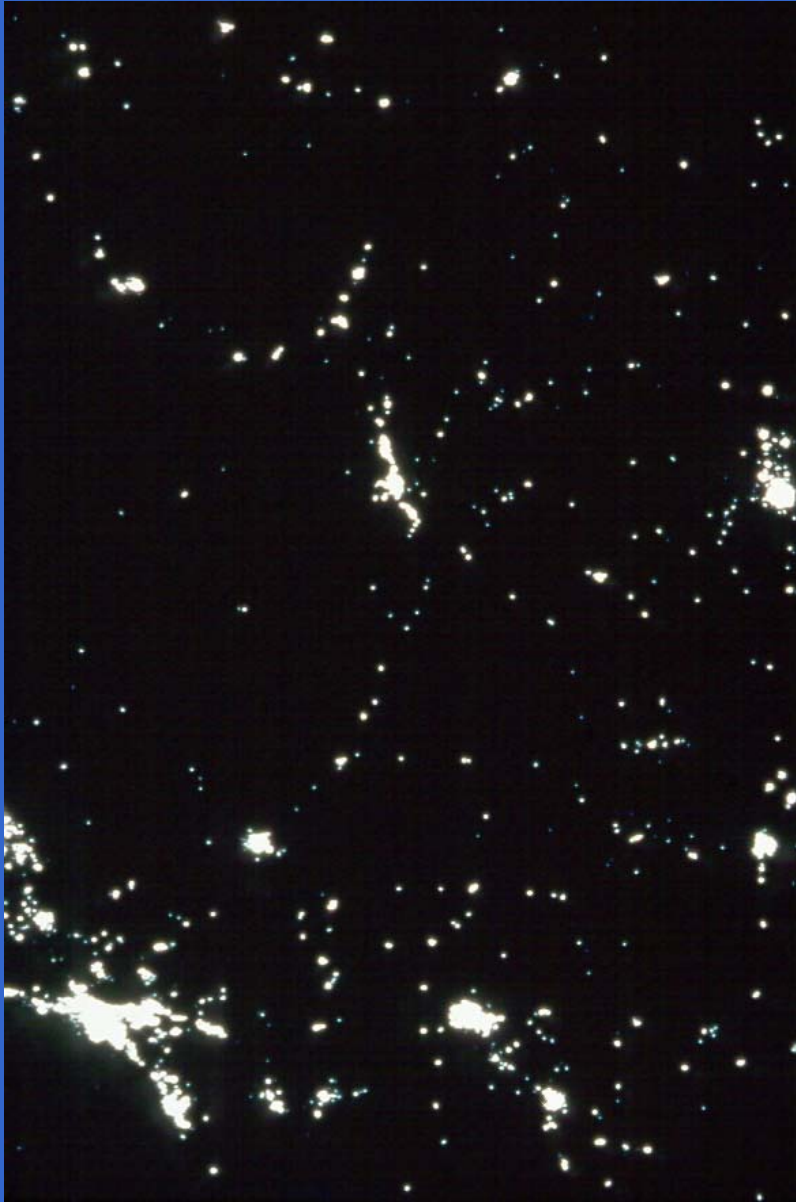
The Earth at Night



North America at Night



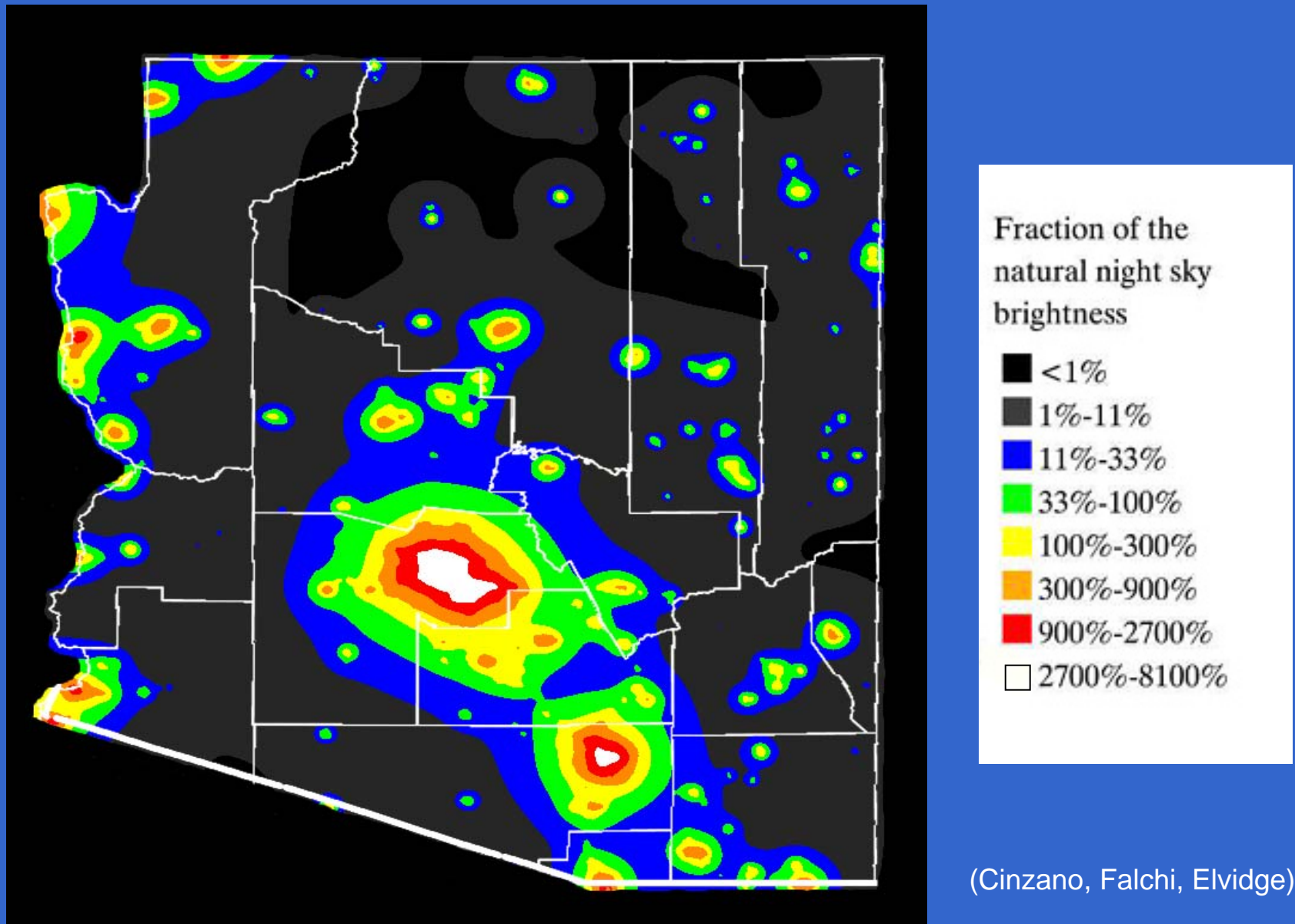
Southwestern United States, home of many of the large telescopes in the continental United States.



Lights as seen from above, as from the International Space Station, for example, looking down. Here the landscape outside of the cities looks dark. But this is misleading... it is not dark here.

The next slide shows what these lights do to the sky, in other words, what it looks like looking upwards, the other direction, showing that light pollution spreads much farther than the cities in which the lights are used... you can be 50 or 100 miles from the Phoenix metropolitan area and still see the effects of the city lights

Light Pollution in Arizona



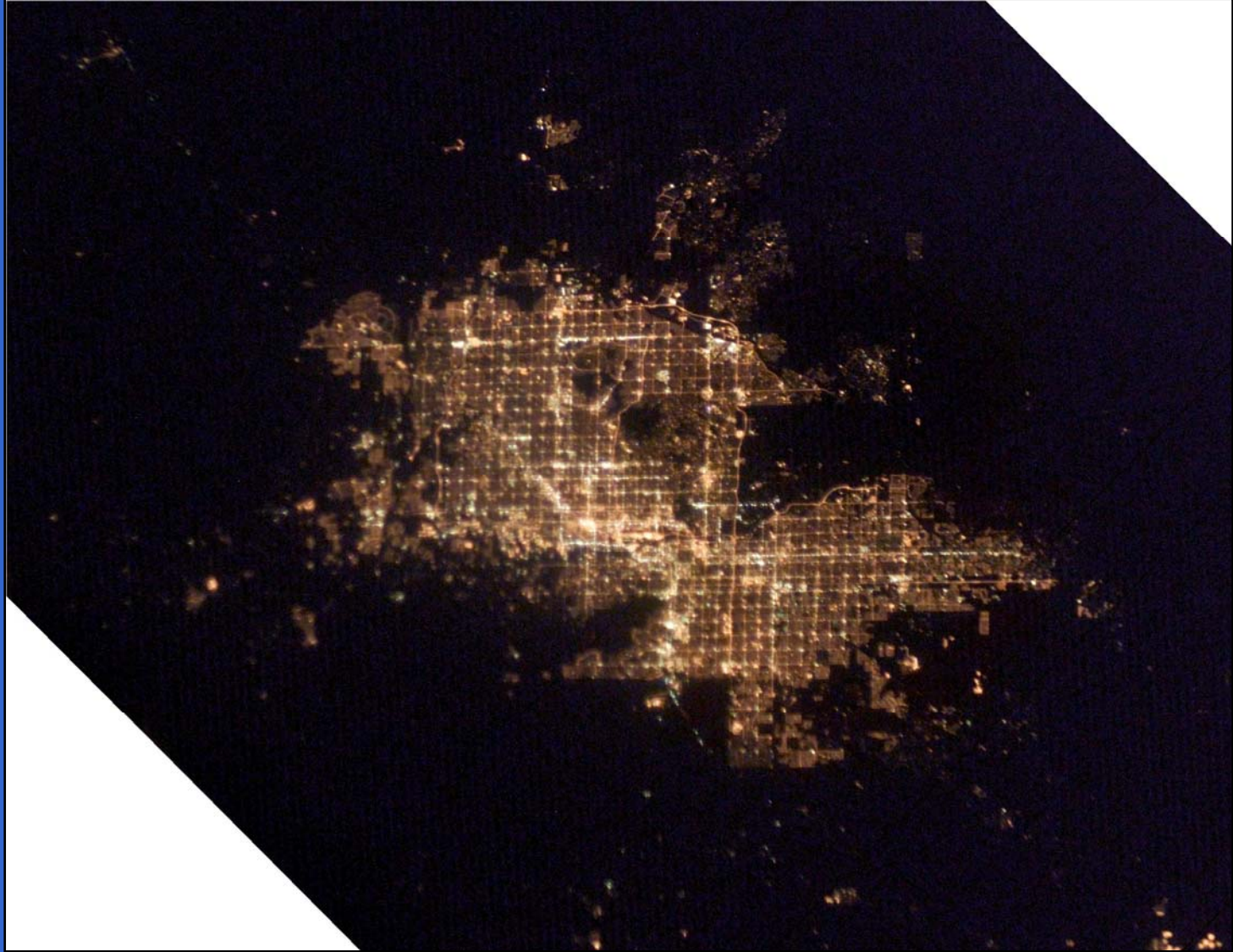


Image of Phoenix at night taken from the International Space Station
(~220 miles above) (NASA, ISS CEO project)

Space Station over Kitt Peak Observatory

~8 p.m. Wednesday, April 11, 2007



The International Space Station (ISS) made a nice pass over Kitt Peak for the 2nd night in a row. Here it is seen trailing through the constellation Cassiopeia and over the 36 inch Spacewatch Telescope dome (with the 90 inch Bok telescope and 4-meter Mayall Telescope domes at right). **The orange glow is not twilight - that is the glow of city lights from Phoenix and Casa Grande.** This image was taken with my 24mm lens with an exposure of 30 seconds at f/1.8, ISO 200. (Jim Scotti, LPL)



Phoenix/Casa Grande sky glow as seen from Kitt Peak National Obs.

March 28, 2008. (KPNO photo by J. Glaspey)



Light Pollution at Mt. Graham as seen from LBT dome, March 10, 2008.



|
Tucson

Tucson

70 miles

|
Phoenix

Phoenix

140 miles

Light Pollution at Mt. Graham as seen from LBT dome, March 10, 2008.

(Photo by Marco Pedani, LBTO)

Phoenix from Flagstaff, 125 miles away

\$

Reduced Energy Use and Carbon Dioxide Emissions from Improved Outdoor Lighting Efficiency in Arizona

Christian B. Luginbuhl, US Naval Observatory Flagstaff Station

G. Wesley Lockwood, Lowell Observatory

10 January 2008

Summary

We estimate potential energy savings and carbon dioxide emission reductions if lighting standards similar to Flagstaff's could be applied to all commercial outdoor lighting within the state.

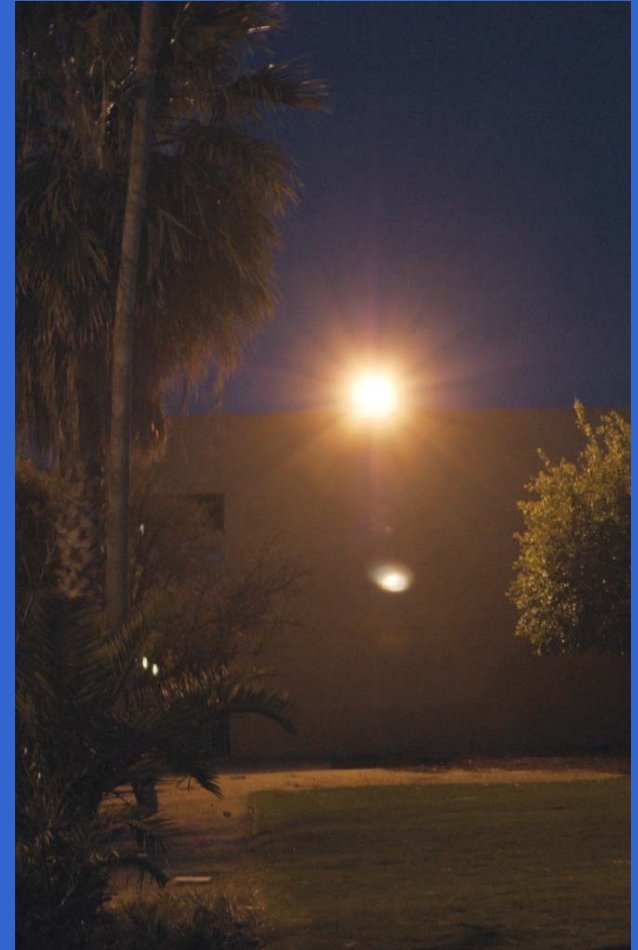
The results show that statewide energy use would be reduced by at least 360,000 MWh/yr. This figure corresponds to a reduction of 190 kilotons of CO₂ emissions per year with an energy cost savings of \$30 million per year.

Purpose of a Lighting Code:

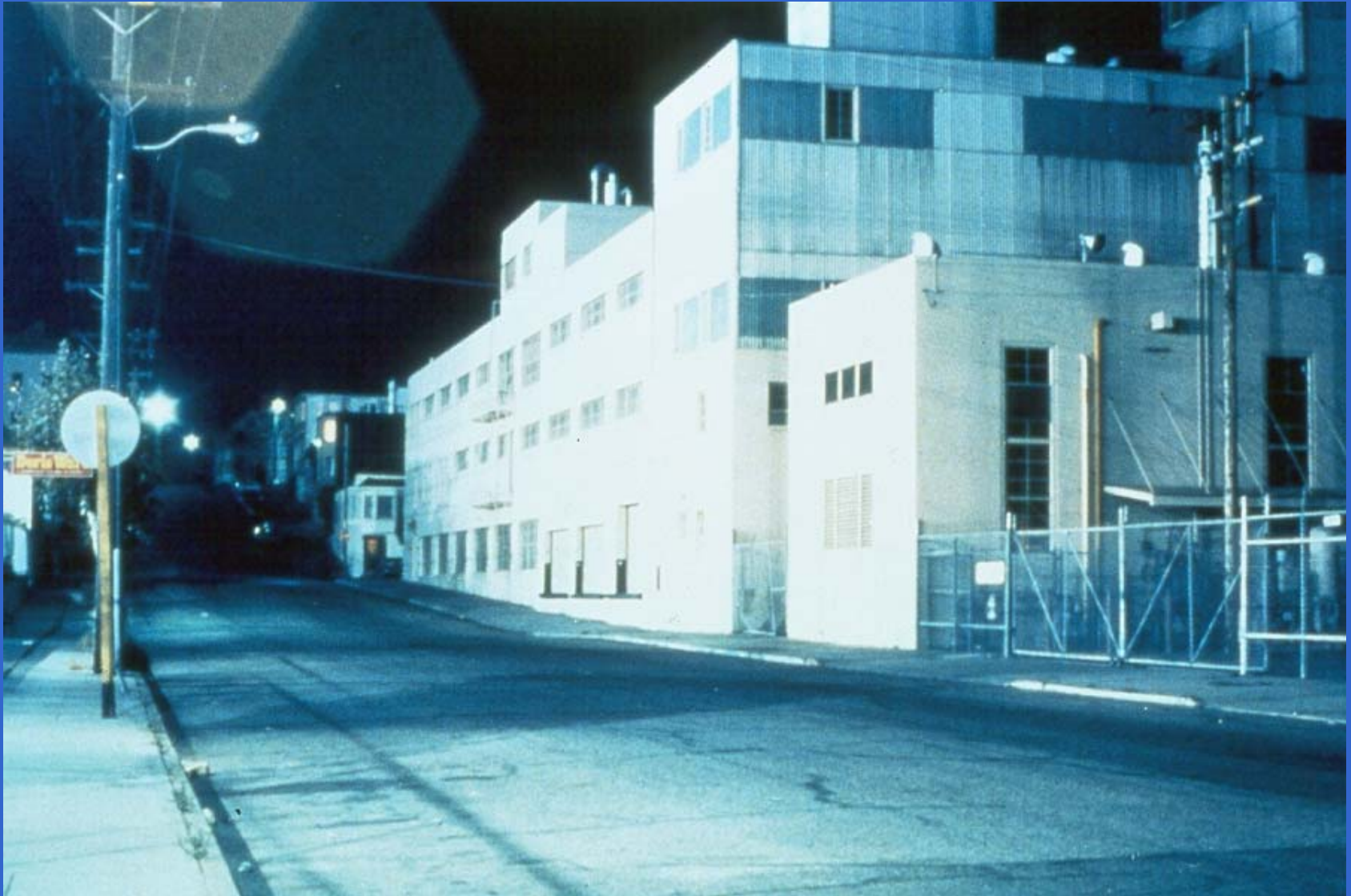
- Promote good lighting practice,
 - And to limit obtrusive lighting.
- Promote good business.
- Promote the community.
- Help everyone see better.
- Save energy. Save money.
- Preserve dark skies for all.

The Biggest Complaints

- Too much light.
 - neighbor's lights.
- Glare.
 - Wall packs, “security” lights, floodlights.
- Can't see well anymore.
- Light trespass
- Not comfortable; it's obtrusive light.



Almost a definition of light trespass,
at an installation in San Francisco.





Thorpe Park, City of Flagstaff
1970's vintage sport lighting
Note glare and spill lighting



Thorpe Park, City of Flagstaff
Modern sport lighting circa 2006

Benefits:

Light levels on playing field are twice previous.

Players and spectators can see better.

No light trespass into surrounding neighborhood.

Better energy efficiency.

Everyone wins.

How is this for a good lighting design?
Bureaucracy in action!



A view of a parking lot, one lit by glary lighting.



Same view, but with a flash photograph to show where he is.

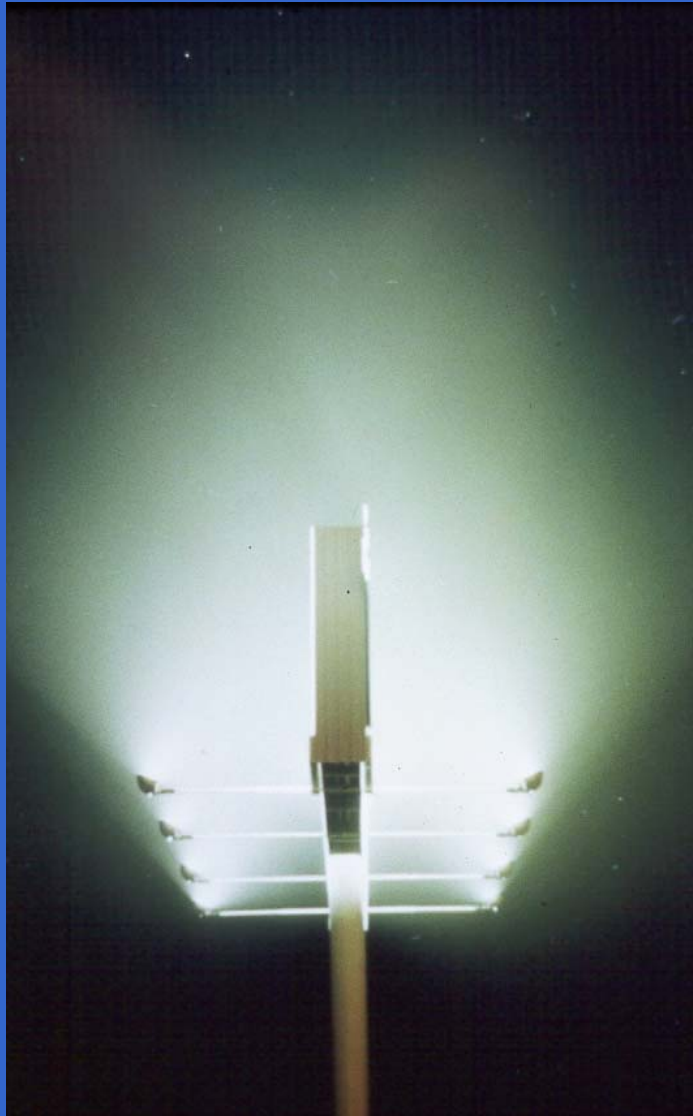


Maricopa County Outdoor Light Control Provisions Comments and Suggestions

The current outdoor lighting control provisions (Section 1112 of the Maricopa County Zoning Ordinance) were adopted in 1984. In the ensuing nearly quarter-century much has been learned about effective outdoor lighting standards, and, much has changed in the technology of outdoor lighting.



A bottom-lit billboard, seen from the side.





Top-mounted billboard lighting

LED billboards
being installed on
the 202 Freeway in
Tempe



We respectfully raise these topics for consideration with regard to possible improvements and updates to MAG outdoor lighting codes:

- All lighting fixtures above a given brightness should be fully shielded (so that all light is directed downward where it is useful).
- Implement standards to address the amount of outdoor lighting used in order to limit over-lighting and save energy.
- Adopt separate residential lighting standards to address the specific issues encountered in residential zones (typically light trespass). This would relieve homeowners and builders from having to wade through the more complex standards for non-residential development.
- Re-work code definitions and standards using terminology and methods more easily implemented by planning staff and lighting users.

We suggest the purpose of these regulations:

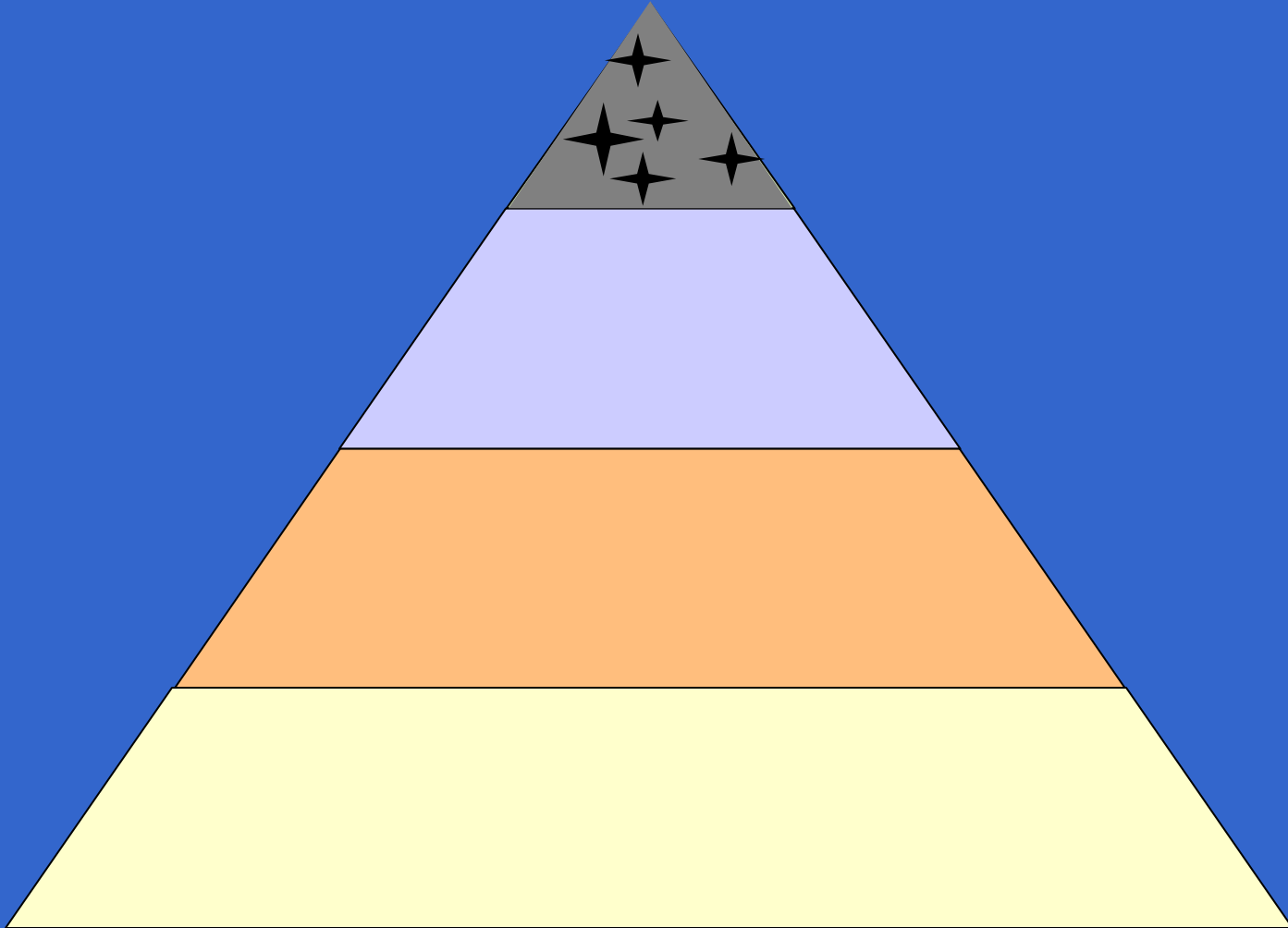
- * Permit reasonable uses of outdoor lighting for nighttime safety, utility, security, and enjoyment while preserving the ambiance of the night;
- * Minimize glare and obtrusive light by limiting outdoor lighting that is misdirected, excessive, or unnecessary;
- * Conserve energy and resources to the greatest extent possible;
- * Help protect the natural environment from the damaging effects of night lighting.



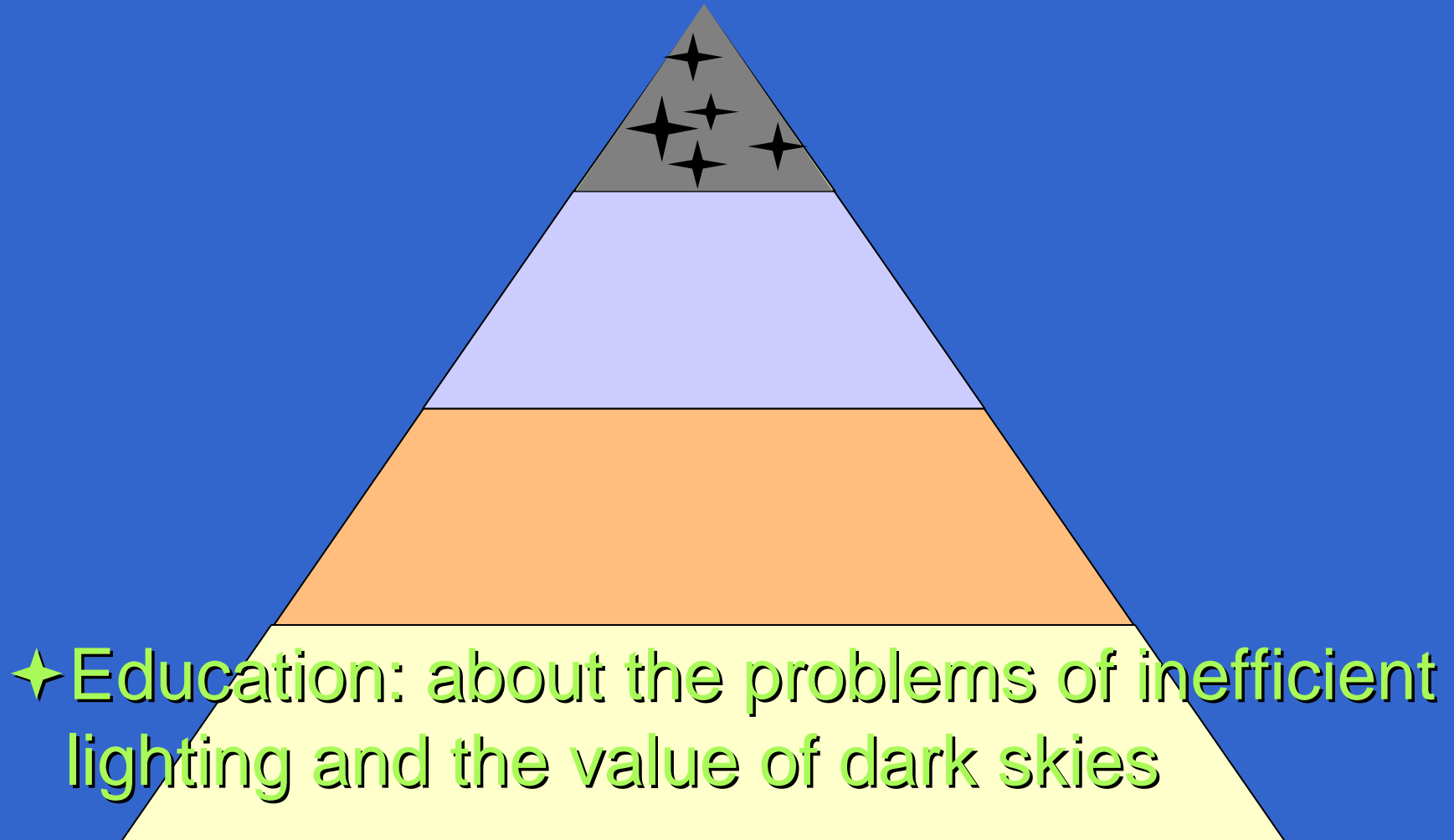
On the night of August 20, 2003, a blackout plunged millions of people across northeast North America into darkness. The left photo shows the glow filling the skies over photographer Todd Carlson's house in Goodwood, Ontario, Canada, (near Toronto).

Photos copyright © 2003, Todd Carlson, used with permission.

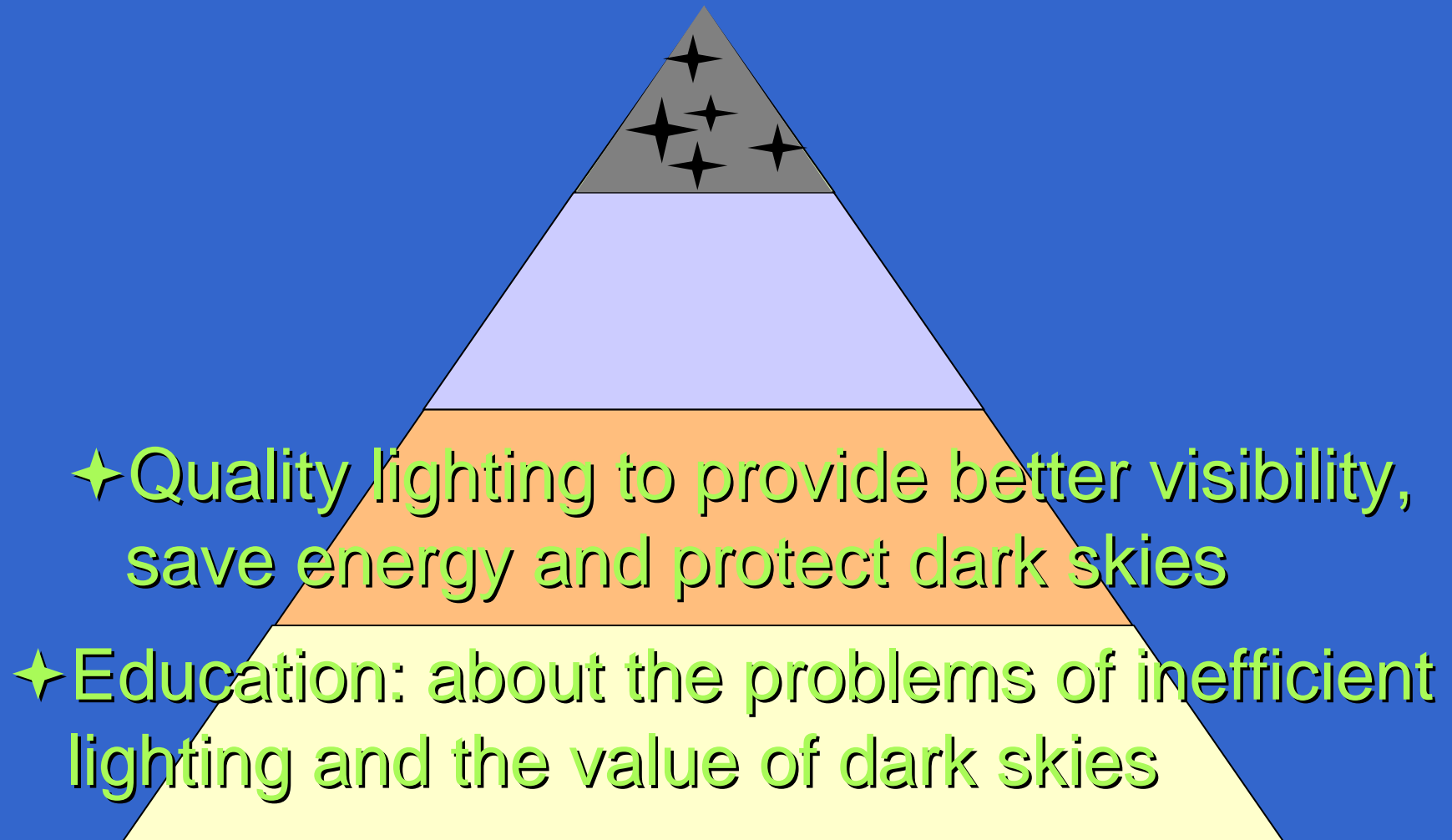
What is the solution?



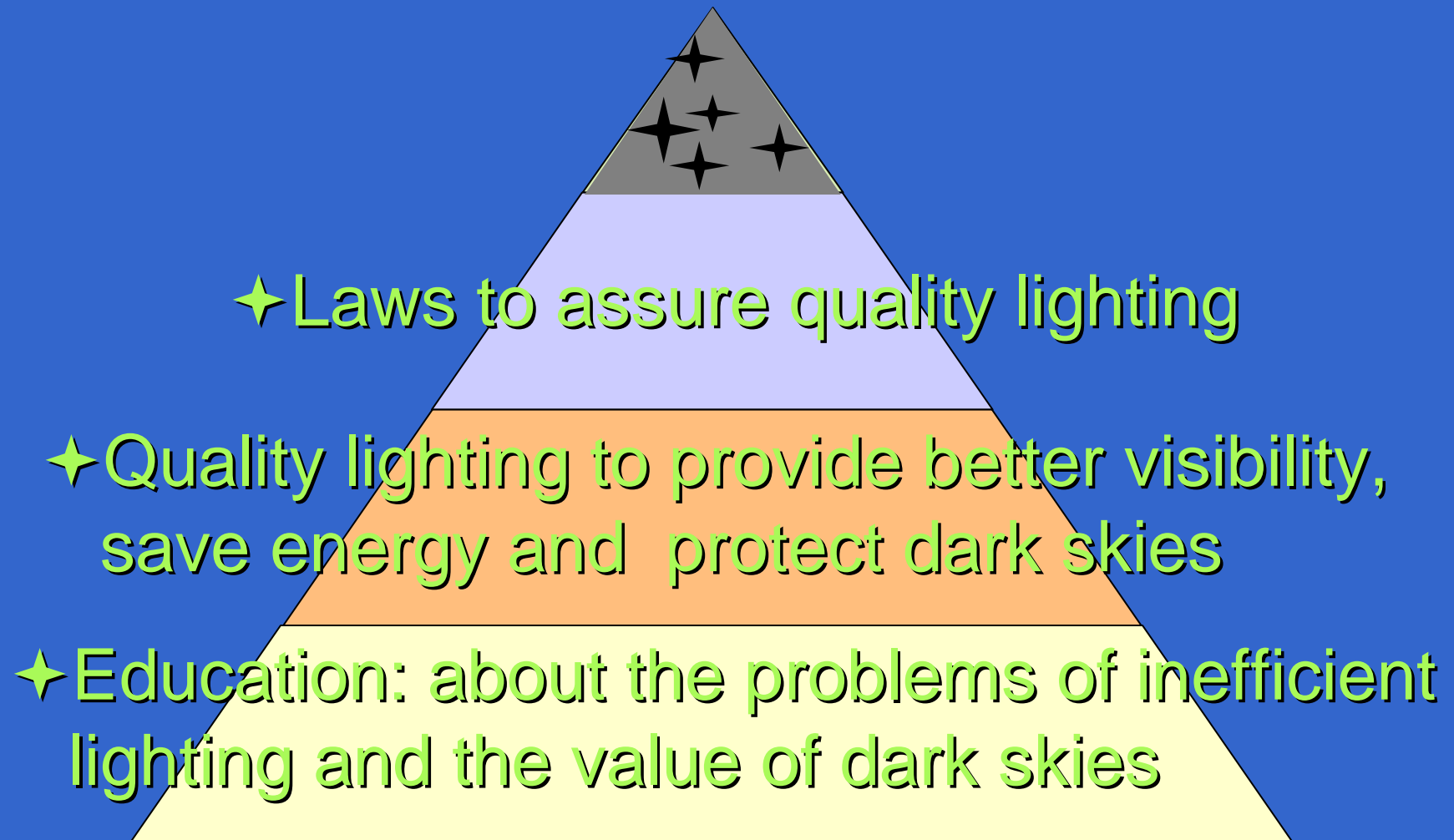
What is the solution?



What is the solution?



What is the solution?



Where do we go from here?
Form a working group of
interested parties?
Is the Maricopa Association of
Governments an efficient way to
reach many jurisdictions?

The Astronomy Community stands
ready to help.

The International Dark-Sky
Association has a wealth of
resources including a light fixture
testing program.

www.darksky.org

NGC 1818: A Young Globular Cluster
Credit: Diedre Hunter (Lowell Obs.) et al., HST, NASA





A Protected Night Sky Over Flagstaff

(Credit and Copyright: Dan & Cindy Duriscoe, FDSC, Lowell Obs., USNO)

